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Original Research Article

Value of modified Burns Wean Assessment Program scores in the respiratory intensive care unit: an Egyptian study

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ABSTRACT

Background: There is no consensus on the most useful predictive indicator for weaning patients from mechanical ventilation (MV). We aimed to evaluate the utility of the modified Burns Wean Assessment Program (m-BWAP) in predicting the weaning success in patients with respiratory disorders admitted to the respiratory intensive care unit (RICU).
Methods: Patients with respiratory failure requiring MV for longer than 48 hours were included. They were weaned by pressure support ventilation and spontaneous breathing trails. Patients were divided into successful and unsuccessful weaning groups according to their outcomes.
Results: A total of 91 patients were enrolled. The majority had chronic obstructive pulmonary diseases (COPD): 40%, overlap syndrome (24%), and obesity hypoventilation syndrome (OHS): 15%. The successful group had significantly higher m-BWAP scores than that in the unsuccessful group (median 65; range 35 to 80 vs. median 45; range 30 to 65; p=0.000), with area under the curve (AUC) of 0.854; 95% CI 0.766 to 0.919), p<0.001. At cut-off value of ≥55, the sensitivity and specificity of m-BWAP to predict successful weaning were 73.77% and 84.85%, respectively. The AUC for m-BWAP was significantly higher than that for rapid shallow breathing index (RSBI).
Conclusion: We conclude that m-BWAP scores represent a good predictor of weaning success among patients with chronic respiratory disorders in the RICU. The m-BWAP checklist has many factors that are closely related to the weaning outcomes of patients with chronic respiratory disorders. Further, large-scale, multicenter studies are warranted.

Key words: Modified Burns Wean Assessment Program scores; respiratory; ICU; Egypt; weaning.

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Introduction

Mechanical ventilation (MV) is an integral part of management for patients with respiratory failure, due to different respiratory disorders, in the intensive care unit (ICU) [1,2]. Weaning covers the entire process of liberating the patient from mechanical support as well as from endotracheal tube, which can take more than 56% - 90% of the time of MV [3]. Determining the patient's readiness for the process of weaning from MV is of crucial importance. However, it is not an easy task to wean a patient with respiratory failure due to respiratory disorder from the MV. Because MV itself is associated with many complications, as well as weaning patients improperly from MV can lead to respiratory failure and re-intubation, the decision of weaning still represents a challenge to the respiratory physician [2,4].

Early weaning and unsuccessful extubation can lead to tracheal reintubation, which potentially leads to airway trauma, aspiration, acute lung injury, and increases the risk of nosocomial pneumonia and the mortality rates [5]. On the other hand, late weaning exposes the patients to pneumonia, ventilator-induced lung injury (VILI) and higher mortality [6].

Despite the fact that many weaning parameters and predictors have been reported in the literature, there is no consensus on the most useful predictive indicators [7-9], particularly in patients with respiratory disorders [4,10].

A comprehensive clinical weaning checklist and scoring instrument, the Burns Wean Assessment Program (BWAP) score was designed to assist the clinicians in the management of patients who require prolonged MV [11]. Moreover, a modified version of the BWAP score (m-BWAP) has been developed, which makes the scoring more convenient, and proved effective as a good indicator of weaning and extubation outcome in patients with long-term mechanical ventilation (LTMV) [12]. However, no study had evaluated this score in patients with respiratory failure due to respiratory disorder. Therefore, this study aimed to evaluate the modified Burns Wean Assessment Program (m-BWAP) score in predicting weaning success in mechanically ventilated respiratory patients due to respiratory failure for more than 48 h.

Materials and Methods

Study design and subjects

Assiut University Hospital (AUH) is a large tertiary hospital in Upper Egypt, to which many patients with respiratory disorders are referred. This prospective, observational study was conducted in a 24-bed respiratory ICU at AUH, from the period of January 2019 to July 2019.

Inclusion criteria were; adult subjects with the diagnosis of respiratory failure due to a respiratory disorder who are mechanically ventilated for ≥48 h with the absence of uncontrolled respiratory infection, and in a clinical and neurological stable state. Subjects aged younger than 18 years, those with irreversible brain injury, acute or chronic neuromuscular diseases, LTMV prior to ICU admission, and those who received tracheostomy before the first spontaneous breathing trial (SBT) were excluded. A ventilator weaning protocol, based on documented guidelines, has been developed [1,4], and successfully implemented in our respiratory ICU (Figure 1).

All patients were monitored with ECG, blood pressure and pulse oximetry. Patients were assigned for a spontaneous breathing trial (SBT) for 30 min when they met the following criteria: PaO_2/FiO_2 >150, PEEP ≤8 mmHg, stable neurological state, mean blood pressure ≥60 mmHg and adequate cough. All patients were weaned by low level of pressure support (5-8 cmH_2O) and FiO_2 levels decreased gradually until ≤40%. Patients showed good tolerance for the trial: acceptable arterial blood gas (pH ≥7.35, PaO_2/FiO_2 >150 with a FiO_2 ≤40%, respiratory rate ≤35 breaths/min), they were extubated and followed for 48 h. Weaning success means the ability to maintain spontaneous ventilation without the need for reintubation and invasive mechanical ventilation for 48 h after extubation. If signs of intolerance happened (altered mental state, respiratory rate >35 breaths/min, pH <7.32, increase in $PaCO_2$ >10 mmHg, heart rate >140 beats/min, systolic blood pressure >180 or <90 mmHg) turn the ventilator to full support. The study was approved by the Ethical Committee of the Faculty of Medicine, Assiut University.

Data collection and definitions

Demographic and clinical data were collected for each subject; age, gender, body mass index (BMI), and ICU admission diagnosis. The latter was determined according to the well-known international guidelines and agreements. Chronic obstructive pulmonary disease (COPD) was defined as per the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines [13]. The overlap syndrome was defined as the combination of COPD and sleep apnea-hypopnea syndrome (SAHS) [14]. Obesity hypoventilation syndrome (OHS) was defined by the combination of obesity (BMI ≥30 $kg \cdot m^{-2}$), sleep disordered breathing and day-

A. Daily assessment for readiness to wean	**Yes**	**No**
1) Reversal of the underlying cause for acute respiratory failure [1,13]	○	○
	go to 'B'	reassessed next day
B. Safety screen for sedation removal [1,4]		
1) Is sedation used for active seizures or alcohol withdrawal?	○	○
2) Is patients is agitation?	○	○
3) Is Paralytics agent used?	○	○
4) Myocardial ischemia occur in past 24 h.	○	○
5) Normal intracranial pressure	○	○
	one or more Yes (reassessed next day)	all No (go to'C')
C. Spontaneous awakening trial safety screen [4,14]		
1) Anxiety	○	○
2) Agitation	○	○
3) Pain	○	○
4) Respiration rate >35 breaths/min for ≥5 min	○	○
5) SpO2 <88% for ≥5 min	○	○
6) Acute cardiac arrhythmia	○	○
7)Two or more signs of respiratory distress (60>HR>120, use of accessory muscles, abdominal paradox, diaphoresis, marked dyspnea)	○	○
	one or more Yes (reassessed next day)	all No (go to'D')
D. Spontaneous breathing trial safety screen [4]		
1- Adequate oxygenation		
① PaO2/FiO2 <150 mmHg or SpO2 <88% on FiO2 ≤0.4 and PEEP ≤5	○	○
② Respiration rate >35 breaths/min	○	○
③Rapid shallow breathing index >105:	○	○
2- Hemodynamic stability		
① Active myocardial ischemia (chest pain, ST changes, new onset arrhythmia)	○	○
② Clinically important hypotension (>5 mcg/kg/min dopamine or dobutamine >0.04 mcg/kg/min norepinephrine)	○	○
③ Heart rate >140 bpm	○	○
	one or more Yes (reassessed next day)	all No (go to'E')
E. Perform spontaneous breathing trial (during 30-120 min) [4,13]		
1) Respiratory rate >35 breaths/min, change in >50%	○	○
2) Heart rate >120 bpm, change in >20%	○	○
3) 90 mmHg>systolic blood pressure >180 mmHg, change in >20%	○	○
4) 2 or more signs of respiratory distress (Use of accessory muscles, abdominal paradox, diaphoresis, marked dyspnea) one or more	○	○
	one or more Yes (reassessed next day)	all No (extubate)

SpO2: blood oxygen saturation; HR: heart rate; PaO2: partial pressure of oxygen; FiO2: fraction of inspired oxygen; PaCO2: partial pressure of carbon dioxide; PEEP: positive end-expiratory pressure; Pi: inspiratory pressure; ST: ST segment on ECG

Figure 1. Weaning protocol at the RICU.

time hypercapnia (arterial carbon dioxide tension ($PaCO_2$) ≥45 mmHg at sea level) during wakefulness occurring in the absence of an alternative neuromuscular, mechanical or metabolic explanation for hypoventilation [15].

The severity of illness within 24 h of ICU admission was measured using the Acute Physiology and Chronic Health Evaluation (APACHE) II score [16]; ICU and hospital length of stay, duration of MV, and hospital mortality were also recorded.

The m-BWAP checklists, as previously reported [12], were used in this study. Enrolled subjects were grouped according to the success of the first spontaneous breathing trial (SBT), into successful and unsuccessful liberation from MV groups, respectively. We also evaluated traditional weaning parameters [rapid shallow breathing index (RSBI), maximal inspiratory pressure (Pimax)] at first SBT to compare predicting successful liberation at first SBT with m-BWAP score. The primary outcome was successful liberation from MV at first SBT, and successful liberation was defined as complete weaning from MV lasting more than 48 h.

Statistical analysis

Continuous variables were expressed as median (range), whereas categorical variables are presented as number (%). The Student *t*-test or the Mann-Whitney U-test were used for comparisons of continuous variables. The Chi-square or Fisher exact test (for small numbers) was used to compare categorical variables. To estimate the performance of the m-BWAP score in terms of predicting successful weaning from MV, receiver operating characteristic curves were constructed and the area under the curve (AUC) was determined; identification of an optimal cut-off value for this score was based on the maximum Youden's index [17]. All tests of significance were two-tailed, and p-values of <0.05 were considered to be statistically significant.

Results

Out of the 125 patients included, 21 (16.8%) died before starting the first weaning trials. Moreover, nine patients (7.2%) were self-extubated or had unplanned weaning (Figure 2). The remaining 95 patients (76%) were divided into two groups; i) successful weaning group, 62 (65.3%) patients, and ii) unsuccessful weaning group, 33 (34.7%) patients. The majority of patients (66/95, 69.5%) were males. At ICU admission, the majority (38/95, 40%) of patients had the diagnosis of COPD, followed by those with overlap syndrome (23/95, 24%), and those with OHS (14/95, 15%).

Patients in the unsuccessful group were older (60.16 ±13.13 *vs* 57.98 ±13.39; p=0.427) with higher APACHE II score than the successful one (23.43±4.49 *vs* 20.04 ±4.56; p=0.428). The distribution of respiratory disorders within successful and unsuccessful groups revealed significant differences. Patients with asthma, overlap syndrome and pneumonia/ARDS were significantly higher among the successful weaning group than in the unsuccessful group (p=0.008, p=0.000, and p=0.031), respectively). While patients with COPD and bronchiectasis were significantly higher among the unsuccessful weaning group than in the successful group (p=0.000, and p=0.031, respectively). Mortality rate was significantly higher in unsuccessful group (30.3% *vs* 12.9%; p=0.000). There were significant differences between the 2 groups with regards to partial pressure of oxygen (PaO_2), mechanical and ventilatory parameters (airway resistance, minute ventilation, maximal inspiratory pressure, lung compliance, and rapid shallow breathing index), as well as modified Burns Wean Assessment Program (m-BWAP). The successful group had significantly higher m-BWAP scores than that in the unsuccessful group (median 65; range 35 to 80 *vs* median 45; range 30 to 65; p=0.000), respectively. Table 1 details the differences between successful and unsuccessful weaning groups.

By analyses according to all m-BWAP scoring checklist elements [12], the successful group had a significantly higher rate in nine factors of all checklist elements when compared with the unsuccessful group (*i.e.*, stable heart rhythm, general body strength and condition, ability to clear airway, amount and consistency of secretion, good lung compliance, low airway resistance (Raw), low Pimax, low RSBI, and appropriate minute ventilation) (Table 2)

The m-BWAP score was higher in patients with successful weaning using a cut-off value of ≥55. At this cut-off value, the sensitivity and specificity of the m-BWAP to predict successful weaning were 73.77% and 84.85%, respectively (AUC 0.854; 95% CI 0.766 to 0.919), p<0.001 (Figure 3).

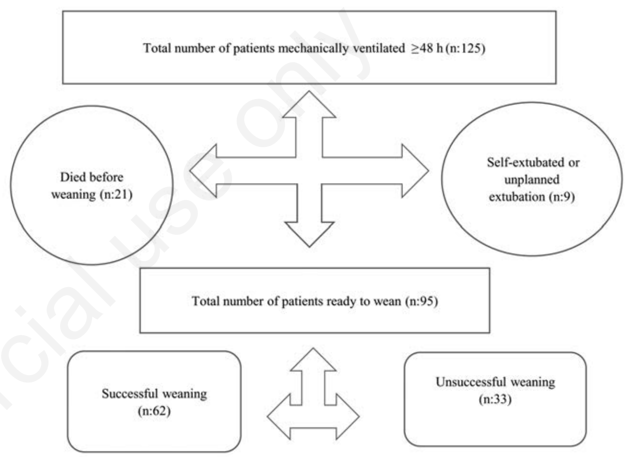

Figure 2. Flow chart of the studied patients.

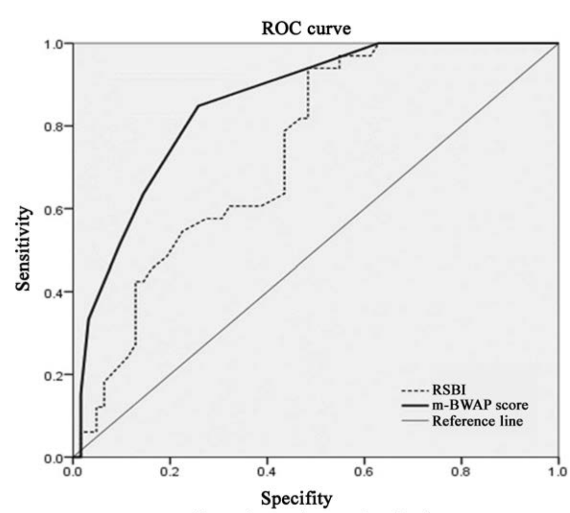

Figure 3. Receiver operating characteristic curves for modified Burns Wean Assessment Program (m-BWAP) score and rapid shallow breathing index (RSBI) for predicting successful weaning from mechanical ventilation in RICU patients. The areas under the curve (AUCs) for m-BWAP and RSBI were 0.854 (95% CI: 0.766 to 0.919), p<0.001, and 0.740 (95% CI: 0.637 to 0.823), p<0.001, respectively.

Table 1. **Clinico-physiological features of patients with successful and unsuccessful weaning from mechanical ventilation.**

	Successful group (n=62)	Unsuccessful group (n=33)	p
Age (median ± SD, years)	57.98 ±13.39	60.16 ±13.13	0.427
Gender (n, %)			
Female	17 (27.4%)	12 (36.4%)	0.251
Male	45 (72.6%)	21 (63.6%)	
Severity of illness at ICU admission			
APACHE II score	20.04 ±4.56	23.43±4.49	0.488
Time between ICU admission and weaning (days)*	2.67±1.30	3.78±1.82	0.002
Underlying respiratory disorder (n,%)			
Asthma	5 (8.1%)	0 (0%)	0.008
COPD	22 (35.5 %)	16 (48.5%)	0.000
Bronchiectasis	3 (4.8%)	3 (11.0%)	0.031
Overlap syndrome	18 (29.0%)	5 (15.2%)	0.000
OHS	8 (12.9%)	6 (18.2%)	0.063
Pneumonia/ ARDS	4 (6.5%)	0 (0%)	0.031
Others°	2 (3.2%)	3 (11.0%)	0.008
Laboratory and functional parameters			
Hemoglobin	13.16±2.25	12.32±2.58	0.095
Albumin	28.65±5.04	26.11±4.78	0.014
pH	7.45±0.04	7.44±0.06	0.255
$PaCO_2$	54.08±10.62	56.22±12.51	0.369
PaO_2	74.86±13.98	67.40±12.93	0.008
Raw	8.68±3.09	15.91±3.47	0.000
Pimax	21.19±5.53	13.97±4.43	0.000
MV	7.02±2.45	11.75±2.57	0.000
RR	23.26±5.35	35.82±3.20	0.000
LC	42.21±10.73	28.22±7.61	0.000
RSBI	78.59±26.886	121.33±18.45	0.000
m-BWAP	65 (35-80)	45 (30-65)	0.000
Length of stay in the ICU#	6.51±4.58	12.89±8.64	0.000
Hospital mortality	8 (12.9%)	10 (30.3%)	0.000

APACHE II, Acute Physiology and Chronic Health Evaluation II score; WBC, White blood cells; ALB, serum albumin; PaO2, partial pressure of oxygen; PaCO2, partial pressure of carbon dioxide; MV, minute ventilation; Hg, hemoglobin; PLT, platelets; Na, sodium; K, potassium; Raw, airway resistance; Pimax, maximal inspiratory pressure; RR, respiratory rate; LC, lung compliance; COPD, chronic obstructive pulmonary disease; OHS, obesity hypoventilation syndrome; ARDS, acute respiratory distress syndrome; *duration before weaning was defined as the time from intubation until first spontaneous breathing trial; ° Others; 2 post-pulmonary TB sequelae; 2 interstitial lung disease; and one pulmonary embolism; #length of stay in ICU was defined as the time from intubation until ICU discharge. Data presented as mean ± SD; median (range); number (%).

Table 2. **Comparison of m-BWAP scoring tools between patients with successful and unsuccessful groups.**

Item	Successful group (n=62)	Unsuccessful group (n=33)	p
Age <65 years	37 (59.7%)	23 (69.7%)	0.343
Without heart failure	56 (90.3%)	27 (81.8%)	0.235
Stable heart rhythm	53 (85.5%)	18 (54.5%)	0.001
Stable blood pressure	56 (90.3%)	26 (78.8%)	0.058
Free from factors that will increase or decrease metabolic rate	52 (83.9%)	24 (72.7%)	0.196
Stable arterial blood gases pH	41 (66.1%)	18 (54.5%)	0.066
Stable PaO_2 and $PaCO_2$	33(53.2%)	17 (51.1%)	0.874
Good consciousness	0 (0%)	0 (0%)	-
Stable sodium, potassium, calcium, and phosphate concentration	46 (74.2%)	21(63.6%)	0.053
Stable fluid status	0 (0%)	0 (0%)	-
Good nutritional status	23 (37.1%)	12(36.4%)	0.944
General body strength and condition	20 (32.3%)	4 (12.1%)	0.032
Ability to clear airway	26 (41.9%)	2 (6.1%)	0.000
Amount and consistency of secretion	54 (87.1%)	17 (51.1%)	0.000
Good lung compliance	58 (93.5%)	21 (63.6%)	0.000
Low Raw	58 (93.5%)	13 (39.4%)	0.000
Low Pimax	46 (74.2%)	11 (33.3%)	0.000
Low RSBI	54 (87.1%)	19 (57.6%)	0.000
Appropriate minute ventilation	55 (88.7%)	11 (33.3%)	0.000

This table shows the comparison between patients with successful and unsuccessful liberation of ventilator care at the time of first SBT in total patients regardless of whether they had 5 points or not according to the definition of each category. m-BWAP, modified Burns Wean Assessment Program; PaO_2, partial pressure of oxygen; PaCO2, partial pressure of carbon dioxide; Raw, airway resistance; Pimax, maximal inspiratory pressure; RSBI, rapid shallow breathing index. Values are presented as number (%).

Upon comparing the m-BWAP score with other weaning parameters (RSBI), at a cut-off value of ≥83 for RSBI, the AUC was 0.740 (95% CI: 0.637 to 0.823), p <0.001. The sensitivity and specificity of RSBI to predict successful weaning were 51.61% and 93.94%, respectively. The AUC for m-BWAP was significantly higher than that for RSBI (Figure 3).

Discussion

To the best of our knowledge, this is the first study that evaluates the m-BWAP score in weaning from mechanical ventilation of a well-characterized group of adult patients with different respiratory disorders admitted to RICU. We had observed that the m-BWAP score could be successfully applied to Egyptian adult patients with different respiratory disorders. The m-BWAP score was higher in patients with successful weaning using a cut-off value of 55, with sensitivity and specificity of 73.77% and 84.85%, respectively. Moreover, upon comparing the m-BWAP score with other weaning parameters (RSBI), m-BWAP proved to be more effective tool for predicting weaning from mechanical ventilation in patients with chronic respiratory disorders.

Our demographic data showed that days of mechanical ventilation before weaning, and length of ICU stays affected weaning success. This was in accordance with the findings of Wu, *et al* [18]. Also, in agreement with Shin *et al.* [19], we had reported that APACHE II score was significantly lower in the successful weaning group.

In patients with chronic respiratory disorders, systematic tracking of factors associated with successful weaning remains important for care planning and to determine the weaning potential. This is of particular importance because almost all chronic respiratory disorders affect -in a way or another- the lung mechanics and/or the ventilatory control [20], so the preparation for weaning a patient with chronic respiratory disorder is of crucial importance and represents a challenging task for the pulmonologist and/or the intensivist. This task will be harder in patients with combined respiratory disorders (e.g., overlap syndrome, obesity hypoventilation syndrome) [9,20,21]. Our study included considerable numbers of patients with different respiratory disorders. Moreover, patients with asthma, overlap syndrome and pneumonia/ARDS were significantly higher among the successful weaning group than those in the unsuccessful group. On the contrary, patients with COPD and bronchiectasis were significantly higher among the unsuccessful weaning group than those in the successful one.

Patients with COPD are well known to have pathophysiologic abnormalities like airway obstruction, dynamic hyperinflation, diaphragmatic muscle abnormalities, ventilation-perfusion mismatch [13]. The overlap syndrome can contribute to worsened symptoms and oxygen desaturation at night. Alveolar hypoventilation, ventilation-perfusion mismatch and intermittent hypercapnic events resulting from apneas and hypopneas contribute to the final clinical picture of overlap syndrome, which is quite different from the "usual" COPD [22]. On the other hand, the pathophysiology of OHS results from complex interactions, among which are respiratory mechanics, ventilatory control, sleep-disordered breathing and neurohormonal disturbances, such as leptin resistance, each of which contributes to varying degrees in individual patients to the development of obesity hypoventilation [22,22]. Spontaneous breathing assessment was a routine practice carried out for all mechanically ventilated patients [23]. Different techniques were used to decide if a patient was able to breathe independently. If patients needed more time on the ventilator, the initial requirement for ventilator support was rarely the only reason for continued dependence on a ventilator. Rather, it was mostly the effect of other complications or comorbidities that emerge over time. Thus, a comprehensive assessment of these patients was necessarily needed [24]. The original checklist of Burns wean assessment program (BWAP) was developed as tool to measure patient's readiness for weaning from the ventilator. This tool evaluates parameters of patients' weaning from the ventilator systematically and examines all parameters related to pulmonary function, gas changes, physiological and psychological conditions of patients [9,11]. It is an easy-to-use checklist, and its parameters could be measured within 10 minutes [25]. The modified version of BWAP was developed by Jiang *et al.* [12] who proved that this tool was a good predictor of successful weaning and extubation in patients requiring LTMV for longer than 21 days. Their results also suggested that a m-BWAP score ≥60 is associated with successful extubation outcomes. Jeong and coworkers [4] prospectively enrolled 103 patients in a medical ICU and concluded that m-BWAP score was a good predictor of weaning success in patients with an endotracheal tube in place at first SBT. The current study confirms the findings of Jang *et al.* [12] and Jeong *et al*. [4], and observed that m-BWAP score increased the likelihood of successful weaning among patients with different respiratory disorders in the RICU. Moreover, m-BWAP score was superior to another traditional weaning index (RSBI). Blackwood *et al*. [26] reported that daily assessment for criteria of readiness to wean based on weaning protocols could decrease the duration of mechanical ventilation and length of hospital stay, reduce costs and reduce rates of weaning failure. Thus, our findings could have important clinical and financial impacts, particularly in the setting of developing countries, like Egypt.

In the current study, the successful group showed a significant difference in nine factors of the m-BWAP checklist elements when compared with the unsuccessful group. These factors were; stable heart rhythm, general body strength and condition, ability to clear airway, amount and consistency of secretion, good lung compliance, low Raw, low Pimax, low RSBI, and appropriate minute ventilation.

In their analysis, Jeong and coworkers [4] found different five factors to be significantly different between the successful and unsuccessful groups of weaning. Our results suggest that it is likely that there are more effective factors among the m-BWAP scoring checklist elements among patients with chronic respiratory disorders that can predict successful weaning liberation from MV. Furthermore, we think that one of the major advantages of m-BWAP is that parts of the m-BWAP are better suited for predicting weaning success (mechanics, gas exchange and image studies) while other parts are better for predicting the ability to protect the airway and thus ensure safe extubation (cough ability, secretion content and consciousness). Further multicenter studies with larger numbers of patients with different chronic respiratory disorders are essentially needed.

The current study has several strength points. First, it is the first study that addresses the utility of m-BWAB in "pure" patients with chronic respiratory disorders and admitted in a "respiratory ICU". The pathophysiology of these respiratory disorders is ultimately related to the lung mechanics and the process of weaning from MV. Second, it is a prospective study. Third, our results highlighted the importance of using m-BWAB with the use of more effective factors among its checklist that are more likely to predict, and closely related to the successful weaning among patients with chronic respiratory disorders. Inevitably, our study has some limitations. The study sample size was relatively small and the study was performed at a single centre.

Conclusions

We concluded that m-BWAP scores represent a good predictor of weaning success among patient with chronic respiratory disorders in the respiratory intensive care unit. The m-BWAP checklist has many factors that are closely related to the weaning outcomes of patients with chronic respiratory disorders. Additional, large-scale, multicenter studies are needed to further evaluate the clinical utility of m-BWAP scores in patients with chronic respiratory disorders.

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Abbreviations

APACHE II: Acute Physiology and Chronic Health Evaluation;
ARDS: acute respiratory distress syndrome;
AUC: area under the curve;
BMI: body mass index;
CI: confidence interval;
COPD: chronic obstructive pulmonary diseases;
FiO_2: fracture of inspired oxygen;
LC: lung compliance;
LTMV: long-term mechanical ventilation;
OHS: obesity hypoventilation syndrome;
OS: overlap syndrome;
m-BWAP: modified Burns Wean Assessment Program;
MV: mechanical ventilation;
$PaCO_2$: partial pressure of carbon dioxide;
PaO_2: partial pressure of oxygen;
PEEP: positive end expiratory pressure;
Pimax: maximal inspiratory pressure;
Raw: airway resistance;
RICU: respiratory intensive care unit;
RR: respiratory rate;
RSBI: rapid shallow breathing index;
SBT: spontaneous breathing trial;
VILI: ventilator-induced lung injury;
WBC: white blood cells.

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